<u>IN THE SPECIFICATION</u>:

Please delete page 3 in its entirety.

On page 4, please delete lines 1-14.

On page 4, beginning with line 20 and the heading that was added thereon by previous Amendment, please amend the text through the last line of page 4 as follows:

--DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Further scope of <u>the</u> applicability of the present invention will become apparent from the detailed description given hereinafter. However, it should be understood that the detailed description and specific examples, while indicating preferred embodiments of the invention, are given by way of illustration only, since various changes and modifications within the spirit and scope of the invention will become apparent to those skilled in the art from this detailed description.

The device illustrated in Figure 1 is based fundamentally on the device according to U.S. Patent No. 5,069,320 to Falk, the teachings of which are hereby incorporated in this document by reference as if fully set forth herein. <u>In particular, the subject</u>

matter of U.S. Patent No. 5,069,320 (the '320 patent) is relied upon as fully describing a pump mechanism that, in response to relative rotation between a cylindrical sleeve fitted on a cylindrical part, pumps liquid between the engagement surfaces of the sleeve and part for the purpose of negating the friction therebetween. Such a pump mechanism is illustrated in Figure 1 of the '320 patent and described in column 2, line 13, through column 3, line 30, thereof. The general operation of this pump mechanism has also been summarized herein in the foregoing description of the related art and thus is not repeated here.

While the interacting surfaces of conventional devices are comprised of lightly alloyed carbon steel that has been nitrogen case hardened to a depth of about 0.3 mm and has a hardness of about 700 Vickers, according to the present invention one of the parts carries a surface layer which defines one of the interacting surfaces and which is comprised of a material that has a substantially lower plasticizing limit than the interacting surface of the other part. The surface layer may have a thickness of some millimeters, for instance 5 mm, and may, for instance, be comprised of a tin-copper alloy of the tombak kind, e.g., 90% Cu, 10% Sn, 1% Pb. Such an alloy has an elastic limit of about 100 N/m^2. The surface layer may also include cavities in the form of

grooves on its free surface. These grooves are able to form liquid distribution channels for the bearing function. Alternatively, the cavities in the outer layer may contain other recesses or hollows. The reason for these cavities in the surface layer is to ensure that the surface layer material, for instance when melting, has a volume that is smaller than the space between the sleeve and the shaft which was originally occupied by the surface layer. Because the plasticization is meant to eliminate the transmission of power between sleeve and shaft, the cavities in the surface layer will preferably be dimensioned to take into account the fact that the inner diameter of the sleeve decreases when relieved of load, and that the outer diameter of the shaft increases when the load on the shaft is removed, such that the space available for the surface layer will decrease. The layer material shall thus preferably have a net volume that is smaller than the volume for the space between sleeve and shaft after eliminating the radial stress therebetween, and also with respect to the temperature conditions when plasticizing or melting the surface layer (i.e. corresponding volume deviations in respect of the surface layer, the sleeve and the shaft) so that the sleeve is able in principle to rotate free from contact with the plasticized surface layer subsequent to relative rotation between the sleeve and the shaft. This reduces

the risk of the surface layer material being supplied with energy in such quantities as to cause the material to melt as a result of relative rotation between the two main parts of the coupling device.

Plasticization of the surface layer causes successive reduction in the liquid limit or yield stress of the surface layer material. This surface layer limits the torque that is transferred when the hydrostatic bearing function cannot be maintained. The power transmission between the input shaft of the coupling device and its output shaft can be monitored and stopped with the aid of external means, for instance by detecting a possible difference in the speed between the input and output parts of the device, for limiting the relative rotation between the parts.

The present invention is effective in preventing damage to the driven equipment and also to the driving equipment, and also limits damage to the torque-limiting device.

The coupling can be readily renovated subsequent to plasticization (which may lead to melting of the surface layer), by heating said layer and that part (the shaft) that carries the surface layer. Because the surface layer is comprised of material (tombak) that has a high coefficient of thermal expansion, the layer will loosen from the base of said part (the shaft) and be

easily drawn off the shaft. A replacement surface layer in the form of a tombak-sleeve can be simply inserted into/pushed over the part concerned (10, 20) and fastened thereto by means of a glue joint, for instance, this joint being destroyed by the heat applied in the renovating process or in conjunction with plasticization of the surface layer.

~~The~~ As shown in Figure 1 as set forth herein, the coupling device basically comprises a cylindrical trunnion 10 and a sleeve 20 that embraces the trunnion/shaft 10, said shaft 10 and sleeve 20 having respective flange connections 11 and 21 for connecting up a drive system, for instance a large electric motor and a roll belonging to a steel rolling mill. The sleeve 20 has an inner surface 22 that co-acts with an outer surface 12 on the shaft 10. There is included in the sleeve wall an oil chamber A that can be placed under pressure by pumping in oil at a pressure, e.g., in the range of 0-50 mPa, to cause frictional engagement at the interface B between the mutually co-acting surfaces 12, 22. The frictional grip and the maximum torque that can be transferred are determined by the oil pressure in the chamber A. After pumping oil into the chamber A via a filling channel (not shown), a valve (not shown) in the channel is closed.--

On page 5, please amend the first and second paragraphs, which begin on line 1, as well as the first and second full paragraphs on page 6, as follows:

--The cylindrical sleeve part 20 includes a hub 30 which is mounted for rotation co-axially with the sleeve part 20. The hub 30 carries on its outside a bearing 5 which is eccentric with respect to the hub axle. A number of oil pumps 3 operate radially between the bearing 5 and an inner surface of said sleeve part. The pumps have associated channels 4 through which oil is pumped to the interface B, for instance to its longitudinal center region. The oil spreads along the interface and can, for instance, be collected-up via a channel 41 at one end of the interface B and returned to the pump space. A quantity of oil may be enclosed internally in the pump space, so as to be sucked up by respective pumps immediately and pressed out to the interface B upon relative rotation between the parts 10, 20. The pumps 3 will be set into operation upon such relative rotation, owing to the eccentricity of the outer surface of the hub 30 (the eccentric position of the bearing 5 relative to the parts 10, 20). The outer surface 12 of the shaft 10 that co-acts with the sleeve 20 has a surface layer 50 of tombak (90% Cu, 10% Sn, 1% Pb) <u>that has a first plasticizing limit</u>. The layer 50 has grooves 51 in its free main surface. The

grooves 51 may also be utilized as oil distributing channels for distributing oil from the pumps 3. Oil is pumped from the pump 3 to the longitudinal center region of the interface B, via the channel 4, and flows from there axially to both ends of the interface B, as shown by the arrows in the Figure. A flow of oil is transferred directly back to the pump chamber when collected via the channel 41 extending back to the oil pump chamber.

The space between the shaft 10 and the sleeve 2 is essentially filled by the layer 50, with the exception of the grooves 51 in said layer. The grooves 51 also serve to receive parts of the layer 50 that are plasticized as a result of relative rotation between the parts 10, 20. The surface 22 of the sleeve part 20 <u>has a second plasticizing limit and</u> is comprised of steel and co-acts with the tombak surface of the layer 50. <u>The first plasticizing limit of the surface layer 50 is lower than the second plasticizing limit of the inner surface 22 of the sleeve 20.</u> The tombak layer 50 is able to transfer the torque at normal torque. However, when the torque load exceeds the pre-set value, the steel surface 22 will begin to slide relative to the tombak layer 50. The friction heat and/or the relative movement causes the layer 50 to deform rapidly, as a result of plasticization or melting. The grooves 51 enable the material in the surface of the layer 50 to be

displaced radially in a direction away from the surface 22. Subsequent to the sleeve and shaft having been thus relieved of load in the radial direction, and in view of the state and temperature of the deformed surface layer 50, the net volume of the layer should be accommodated appropriately in the space between the sleeve and the shaft. This reduces the risk of the material of layer 50 receiving so much energy as to cause such material to actually melt. The plasticization results in a successive reduction in the liquid limit of the material, i.e., that point at which the material will turn to a liquid. Normally, in the absence of excessive plasticization or temperature, the material of layer 50 will not pass into a molten phase. As a result of plasticization of the material 50 and the displacement of said material, the power transmission between the parts 10, 20 will be limited even if the pumps 3 are not able to pump oil into the interface B. In other words, if slippage has begun to occur between the parts 10, 20 due to excess torque and the pumps malfunction such that there is insufficient oil between the mutually interacting surfaces to prevent damaging friction caused by the relative movement, the plasticization and displacement of the material 50 provides for the creation of sufficient separation

between the parts 10, 20 to allow the sleeve 20 to rotate *free from contact* with the shaft 10.

The frictional engagement between the shaft and the sleeve can, of course, be established ~~with~~ by means other than ~~pressurising~~ pressurizing of the hydraulic chamber A as in the illustrated embodiment. For instance, the sleeve and the shaft may be conical and driven axially together so as to achieve a chosen frictional grip, i.e. a chosen upper torque transmission limit. When the sleeve and the shaft have pre-selected dimensions to achieve a given frictional grip, the grip can be achieved by so-called heat shrinkage or by press-fitting the sleeve to the shaft. When the frictional grip is eliminated, i.e. when the radial stress between shaft and sleeve is removed, the outer diameter of the shaft will increase and the inner diameter of the sleeve will decrease. The outer layer should therefore be dimensioned so that its net volume can be accommodated, with a given margin, in the space between the sleeve and the shaft when the friction joint has been eliminated, i.e. when the load on the sleeve and the shaft has been removed radially. Thus, by forming the outer layer 50 with a material that has a relatively low plasticizing limit, it is possible to trigger an initial rotation between the parts 10, 20 in the absence of an oil film

therebetween, at a relatively low torque limit that, nevertheless, lies above the torque limit established by the friction grip between the parts 10, 20 as a result of the initial plasticization of the surface layer material. The material of layer 50 can be said to form a lubricant in the interface between shaft and sleeve. When ensuring that the surface layer can be accommodated in the resultant gap between sleeve and shaft after having relieved the same of load in a radial direction, the transfer of energy to the material of the layer 50 is minimized, as is also the transmission of energy between the shaft and the sleeve.

In order for the surface layer to be able initially to transfer energy between ~~said~~ the two parts, on the one hand, and to collapse and take a state of considerably smaller radial thickness, on the other hand, the outer layer may also include other recesses or hollows additional to the functional grooves on its free surface, for instance pores or the like, in its initial state.--